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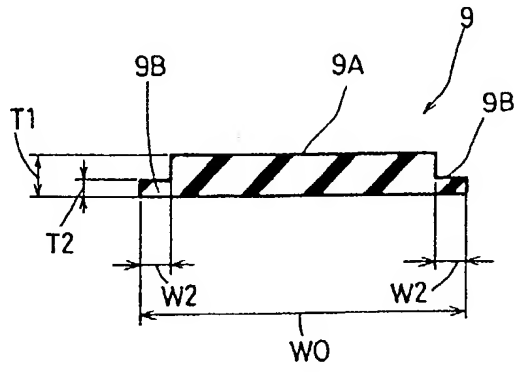
(54) Rubber tape having specific shape to be used in tyre manufacturing

(57) A rubber tape (9) for making up a rubber component of a tyre has a specific shape wherein a fin (9B) is provided on each side of a central part (9A), the central part (9A) has a thickness (T1) of 0.3 to 1.5 mm, the fin (9B) has a thickness (T2) less than the thickness (T1) and a width (W2) of from 0.5 to 5.0 mm. A method of manufacturing a tyre comprises a step of making at least one of its rubber components by winding the rubber tape (9). An apparatus for making the rubber tape (9) comprises an extruder (13) and a pair of calendar rollers (14), wherein the extruder (13) includes a die (17) having an extruding hole (16) from which compounded rubber is extruded into a rectangular cross sectional shape, the extruding hole (16) has an opening width WA1 of from 0.6 to 0.9 times the whole width W0 of the rubber tape (9) and an opening thickness HA1 of from 1.5 to 7.5 times the average thickness of the central part (9A) of the rubber tape, and the calendar rollers (14) are provided therebetween with a gap between which the extruded rubber passes through, the gap having a shape which is similar to but smaller than a cross sectional shape of the rubber tape.

Fig.3



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Description

[0001] The present invention relates to a rubber tape for making up a rubber component of a tyre, an apparatus for making the rubber tape, and a method of manufacturing a tyre.

[0002] Vehicle tyres, especially pneumatic tyres are made up of a plurality of rubber components, e.g. tread rubber, sidewall rubber, clinch rubber, breaker cushion rubber, inner liner rubber and the like.

[0003] Usually such rubber components are manufactured by extruding unvulcanised rubber into a specific cross sectional shape which corresponds to the finished shape of the rubber component. This shape is determined by a die of the extruder.

[0004] If the rubber component is relatively large, the die becomes large and the size of the extruder can not be reduced.

[0005] Further, it is necessary to prepare a lot of dies, depending on the kinds of the tyres to be produced, the tyre sizes, and the number of rubber components.

[0006] Furthermore, to change the facilities from a certain rubber component to another rubber component, a lot of operations for changing and adjusting the die and the like are necessary.

[0007] Therefore, it is impossible to compact the tyre production line, and it is difficult to establish a flexible manufacturing system.

[0008] On the other hand, in the field of large-sized tyres for construction vehicles, as shown in Fig.10A, it has been proposed to make a tread rubber (e) by winding a rubber strip (a) continuously from one edge to the other edge because it is difficult to extrude a large-sized tyre component since a very high extruding pressure is required. This rubber strip (a) has a rectangular cross sectional shape as shown in Fig.10B.

[0009] If this method is employed in making a rubber component for relatively small sized tyres such as passenger car tyres, the difference of the contour (d) of the wound component from the designed target shape (c) (shown in Fig. 10A by a chain line) becomes large. Further, the surface of the rubber component often corrugates, and lines like cracks are liable to occur on the outer surface of the vulcanised rubber which not only worsens the appearance of the tyre but also decreases the strength and durability of the tyre if the lines are deep. In particular, when such lines occur on a relatively thin rubber layer such as the sidewall rubber, inner liner rubber and the like, the lines become a weak point.

[0010] Further, in comparison with the large-sized tyres, small-sized tyres need dimensional accuracy to a high degree because the tyre size is small, and the flow of rubber during vulcanisation is limited due to the relatively low tyre inflation pressure.

[0011] If the size of the rubber tape is decreased, the difference of the contour may be decreased. If the thickness (at) is decreased to less than 0.6 mm, the corrugation on the surface of the rubber component can be neglected, and the occurrence of defect lines may be prevented. In this case, however, the number of windings is greatly increased, and therefore, the working efficiency and production efficiency greatly decrease, and increased production cost is unavoidable. Further, as the rubber tape becomes thin, air becomes more liable to remain between the windings of the tape and the total volume of retained air increases as the number of the windings increases. Thus, separation or cracks are liable to start form the portions where air remains, and it is difficult to improve tyre durability.

[0012] Therefore, a primary object of the present invention is to provide a rubber tape which can form a tyre rubber component with accuracy without unduly decreasing the thickness and thus can prevent the above-mentioned drawbacks.

[0013] Another object of the present invention is to provide a method of manufacturing a tyre which can establish a flexible manufacturing system.

[0014] Still another object of the present invention is to provide an apparatus for making the rubber tape which is suitably used in the above-mentioned flexible manufacturing system.

[0015] According to one aspect of the present invention, a rubber tape is provided on each side of a central part with a fin, the central part has a thickness of 0.3 to 1.5 mm, and the fin has a thickness less than the thickness of the central part and a width of from 0.5 to 5.0 mm.

[0016] According to another aspect of the present invention, a method of manufacturing a tyre comprises a step of making at least one of rubber components by winding the above-mentioned rubber tape.

[0017] According to yet another aspect of the present invention, an apparatus for making the rubber tape comprises an extruder and a pair of calendar rollers, the extruder including a die having an extruding hole from which compounded rubber is extruded into a rectangular cross sectional shape, the extruding hole having an opening width WA1 of from 0.6 to 0.9 times the whole width W0 of the rubber tape, and an opening thickness HA1 of from 1.5 to 7.5 times the average thickness of the central part of the rubber tape, the calendar rollers provided therebetween with a gap between which the extruded rubber passes through, the gap having a shape which is similar to but smaller than a cross sectional shape of the rubber tape.

[0018] Embodiments of the present invention will now be described in detail in conjunction with the accompanying drawings:

Fig.1 is a cross sectional view of a pneumatic tyre according to the present invention;
Fig.2 is a cross sectional view of a part of a tyre rubber component made of a lap-wound rubber tape;
Fig.3 is a cross sectional view showing an example of the cross sectional shape of the rubber tape;
Fig.4 is a diagram for explaining an effect of the fins of the windings of a rubber tape;
Fig.5A to Fig.5D and Fig.6A to Fig.6E are cross sectional views each showing another example of the cross sectional shape of the rubber tape;
Fig.7 is a cross sectional view of an apparatus for making the rubber tape;
Fig.8 is a cross sectional view showing a gap between calendar rolls;
Fig.9A and 9B are diagrams showing dimensions of an extruding hole and gap used to form the rubber tape shown in Table 1; and
Fig.10A is a cross sectional view showing a tread rubber made according to the prior art and Fig.10B is a cross sectional view of the rubber tape used therefor.

[0019] The tyre 1 shown in Fig.1 is a radial tyre for passenger cars. The tyre 1 is constructed from a plurality of rubber components G made of different rubber compounds and reinforced with cord layers including a carcass 6 and a breaker belt 7.

[0020] The carcass 6 comprises at least one ply of cords arranged at an angle of for example 70 to 90 degrees with respect to the tyre equator C and extending between the bead portions 4 through the tread portion 2 and sidewall portions 3 and turned up around the bead core 5 in each bead portion 4.

[0021] The breaker belt 7 comprises a plurality of plies of cords laid at an angle of from 10 to 35 degrees with respect to the tyre equator C.

[0022] For the carcass cords and breaker cords, organic fibre cords, e.g. nylon, polyester, rayon, aromatic polyamide and the like and steel cords can be used.

[0023] The above-mentioned rubber components G may include

- a tread rubber G1 disposed in the tread portion 2 and defining a ground contacting face,
- a sidewall rubber G2 disposed in each sidewall portion 3 and defining an outer surface of the sidewall portion,
- an inner liner rubber G3 disposed along the inside of the carcass 6,
- a clinch rubber G4 disposed in each bead portion 4 and defining an outer surface of the bead portion,
- a breaker cushion rubber G5 disposed between each edge of the breaker 7 and the carcass 6,
- a bead apex rubber G6 disposed on the radially outside of the bead core 5 and tapering radially outwards.

[0024] In the tyre 1 according to the present invention, at least one of the above-mentioned rubber components G1 to G5 is formed by winding a ribbon-like unvulcanised rubber tape 9.

[0025] The rubber tape 9 is, as shown in Fig.2, wound around a drum 10 so that successive windings are laminated on to each other to give a cross sectional shape close to the target sectional shape P0 of the rubber component G (sidewall rubber G2, in this example).

[0026] The rubber tape 9 is provided on each side of a central part 9A with a relatively thin fin 9B.

[0027] Fig.3 shows an example of the rubber tape 9, wherein the central thick part 9A has a substantially constant thickness T1 and thus it has a rectangular cross sectional shape of a very low aspect ratio.

[0028] Apart from a rectangular cross sectional shape, various shapes can be used as shown in Figs.5A-5D and Figs.6B-6E.

[0029] In Fig.3 and Figs,5A-5D, the fins 9B are positioned such that the base thereof substantially aligns with the base of the central thick part 9A. It is however, not always necessary to align the bases. As shown in Fig.6A-6E, the fins 9B can be formed to protrude in the middle of the thickness of the central thick part 9A.

[0030] Figs.5A to 6E show the following configurations:

Fig.	Top	Base	Symmetry
5A	both edges tapered	flat	Right/Left
5B	one edge tapered	flat	none
5C	half ellipse	flat	Right/Left
5D	reversed-W	flat	Right/Left
6A	flat	flat	Right/Left & Up/Down
6B	both edges tapered	both edges tapered	Right/Left & Up/Down

(continued)

Fig.	Top	Base	Symmetry
6C	one edge tapered	one edge tapered	point
6D	half ellipse	half ellipse	Right/Left & Up/Down
6E	reversed-W	normal-W	Right/Left & Up/Down

[0031] As shown in the figures other than Fig.3 and Fig.6A, the thickness T1 of the central thick part 9A can be changed partially or wholly. But, the thickness T2 of the fin 9B is substantially constant.

[0032] The thickness T1 of the central thick part 9A is set in the range of from 0.3 to 1.5 mm, preferably not less than 0.6 mm. The thickness T2 of the fin 9B is less than the thickness T1, preferably set in the range of from 0.2 to 0.5 mm.

[0033] The width W2 of each of the fins 9B is set in the range of from 0.5 to 5.0 mm. The whole width W0 of the rubber tape 9 can be determined according to the finished cross sectional shape of the rubber component G, but it is usually set in the range of from 5.0 to 40.0 mm.

[0034] Therefore, as shown in Fig.4, when wound onto a former the fins 9B provide an even surface formed by the edges of the windings of the rubber tape 9, and the difference from the target cross sectional shape P0 is thus decreased. Although such a smooth surface can be obtained by winding a very thin rubber tape, the number of windings increases correspondingly and the production efficiency is greatly decreased. In contrast thereto, the rubber tape 9 with fins 9B according to the present invention can reduce the number of windings, and the production efficiency can be improved. Further, trapped or remaining air can be decreased.

[0035] Next, an apparatus 11 for making the rubber tape 9 will be explained according to Fig.7.

[0036] The apparatus 11 comprises an extruder 13 and rollers 14.

[0037] The extruder 13 comprises a main body 13A provided therein with a screw 15 for mixing rubber materials and pushing the mixed compound rubber towards a head 13, the head 13B comprising a die 17 having an extruding hole 16 from which the compounded rubber 12 is extruded in a rectangular cross sectional shape of a low aspect ratio.

[0038] The extruding hole 16 has an opening width WA1 of from 0.6 to 0.9 times the whole width W0 of the rubber tape 9, and an opening height or thickness HA1 of from 1.5 to 7.5 times the average of the thickness T1 of the rubber tape 9.

[0039] The rollers 14 comprise a pair of upper and lower calendar rollers 19U and 19L disposed near the extruding hole 16.

[0040] As shown in Fig.8, a profiled gap K is formed between the upper and lower calendar rollers 19U and 19L. The shape of the gap K is similar to the required cross sectional shape of the rubber tape 9, but the size of the gap is somewhat smaller than the size of the tape 9, and is usually set in a range of 57 to 80 % of the size required.

[0041] In the case of the cross sectional shapes shown in Fig.3 and Figs.5A-5D, the lower calendar roller 19L has a cylindrical surface 19 (flat) and the upper calendar roller 19U is provided with a groove 19 between cylindrical surfaces 19A. Each of the fins 9B is formed by a part K1 between the upper and lower cylindrical surfaces 19A. The central thick part 9A is formed by a part K2 between the grooved part 19B and the lower cylindrical surface 19A.

[0042] In the case of the cross sectional shapes shown in Figs.6A-6E, each of the upper and lower calendar rollers 19U and 19L is provided with a groove 19 between cylindrical surfaces 19A. The fins 9B are likewise formed by the upper and lower cylindrical surfaces 19A. The central thick part 9A is formed by a part between the upper and lower grooved parts 19B.

[0043] As a result the compounded rubber 12 is first extruded into a rectangular shape and then rolled into the final shape. Therefore, the dimensional accuracy and stability is improved. As a result, conventional operations to adjust the width of the rubber tape by cutting off the edges thereof can be omitted. Therefore, the production efficiency is improved.

[0044] If the opening thickness HA1 is more than 7.5 X T1 and/or the opening width WA1 is less than 0.6 X W0, the rubber tape 9 is liable to decrease in the quality and accuracy. If the opening thickness HA1 is less than 1.5 times the average thickness, the extruding pressure increases, and problems such as lowering of the dimensional stability, scorch and the like are liable to occur on the extruded rubber.

[0045] If the opening width WA1 is more than 0.9 X W0, the rubber tape 9 is liable to break during extruding, and the dimensional stability is lost.

[0046] For example, a rubber tape 9 having the cross sectional shape shown in Fig.3 wherein W0 = 22.0 mm, W2 = 2.0 mm, T1 = 0.75 mm and T2 = 0.3 mm can be made with accuracy at a speed of 50 metres/minute under the following conditions: the extruder is a 45mm dia. cold feed extruder; the rotating speed of the screw is 80 RPM; the extruding hole 16 has a shape shown in Fig.9B; the gap K has dimensions shown in Fig.9A; and the extruding speed is about 9 metres/minute.

[0047] Using the above-mentioned apparatus 11, tyres are manufactured.

[0048] The tyre manufacturing method comprises at least a step of making a rubber component G by winding the above-mentioned rubber tape 9 with fins 9B.

[0049] Next, taking a pneumatic tyre especially a radial tyre as an example, a tyre manufacturing method according to the present invention will be described.

[0050] As mentioned above, various rubber components such as the above-mentioned G1 to G6 are made by lap-winding. In this embodiment, the tread rubber G1, sidewall rubber G2, inner liner rubber G3, clinch rubber G4, and breaker cushion rubber G5 are made by lap-winding. However the bead apex rubber G6 is made by means of extrusion as the bead apex rubber G6 and the bead core 5 are assembled into one body on another assembly line.

[0051] The tyre manufacturing method comprises the steps of:

- making each of the sidewall rubbers G2 by winding the specially shaped rubber tape on to a cylindrical winding surface of a tyre building drum;
- making each of the clinch rubbers G4 by winding a special rubber tape on the cylindrical winding surface between the sidewall rubbers G2;
- making the inner liner rubber G3 by winding the rubber tape on the cylindrical winding surface between the clinch rubbers G4;
- making each of the breaker cushion rubber G5 by winding the rubber tape on each of the sidewall rubbers G2;
- winding a carcass 6 on the inner liner rubber G3 and clinch rubbers G4;
- setting a pair of bead-core-and-bead-apex-rubber assemblies on the carcass 6;
- winding other tyre components such as reinforcing layer and the like, if any, on the carcass and/or sidewall rubbers;
- setting an annular tread assembly around the carcass 6;
- expanding the drum such that the carcass between the bead cores 5 becomes a toroidal shape and contacts with the inside of the tread assembly;
- turning up the carcass edges around the bead cores 5 together with the clinch rubbers G4, sidewall rubbers G2 and the like and connecting the sidewall rubbers G2 to the tread rubber G1; and
- vulcanising the assembled raw tyre in a mould.

[0052] The above-mentioned annular tread assembly is composed of a belt 7 (breaker) and the tread rubber G1 disposed on the radially outside thereof, and made by winding belt plies around a profiled belt drum, and then winding a rubber tape 9 therearound as the tread rubber G1.

[0053] Incidentally, the rubber tapes 9 for forming the sidewall rubbers G2, clinch rubbers G4 and inner liner rubber G3 can be wound at the same time to decrease the winding time.

[0054] In the tyre manufacturing method according to the present invention, it is possible to make all the rubber components by winding rubber tapes 2. But it is also possible to make only a specific rubber component or components, for example the sidewall rubbers only, by winding rubber tapes 2.

Comparison Tests

[0055] Pneumatic tyres (Ex. and Ref.) of size 195/65R15 (rim size: 6.0XJJ) for passenger cars were made and checked for defect lines on the outer surface of the tyre and remaining air between the tape windings. In the Ex. tyre, the rubber components G1 to G5 were made by winding rubber tapes shown in Fig.3. In the Ref. tyre, the rubber components G1 to G5 were made by winding rubber tapes shown in Fig.10B.

[0056] Further, an accelerated durability test was made, using a drum type tyre tester, under a tyre load of 6.96 KN, inner pressure of 190 kpa and running speed of 80 km/h. After running for a distance of 30000 km, the rubber components G1 to G5 were checked for cracks or separations.

[0057] The specifications of the tapes used and test results are shown in the following Table 1.

Table 1

Tyre	Ex.	Ref.
Rubber tape		
Sectional shape	Fig.3	Fig.10B
Thickness T1 (at)	1.1 mm	1.1 mm
Thickness T2	0.3 mm	-
Width W0 (aw)	22.5 mm	22.5 mm
Width W2	3.0 mm	-

Table 1 (continued)

Tyre	Ex.	Ref.
Line		
Tread rubber	good	Good
Sidewall rubber	good	Poor
Clinch rubber	good	Poor
Breaker cushion rubber	good	Good
Inner liner rubber	good	very poor
Air		
Tread rubber	good	Good
Sidewall rubber	good	Good
Clinch rubber	good	Good
Breaker cushion rubber	good	Good
Inner liner rubber	good	Good
Durability		
Tread rubber	good	Good
Sidewall rubber	good	very poor
Clinch rubber	good	Poor
Breaker cushion rubber	good	Good
Inner liner rubber	good	very poor

Claims

1. A rubber tape (9) wound to make a rubber component of a tyre, characterised in that the rubber tape (9) is provided on each side of a central part (9A) with a fin (9B), the central part (9A) having a thickness (T1) of 0.3 to 1.5 mm, the fin (9B) having a thickness (T2) less than the thickness (T1) of the central part (9A) and a width (W2) of from 0.5 to 5.0 mm.

2. A rubber tape according to claim 1, characterised in that the rubber tape has a width (WO) in the range of from 5 to 40 mm.

3. A rubber tape according to claim 1, characterised in that the thickness.(T2) of the fin (9B) is substantially constant.

4. A ruboer tape according to claim 1, 2 or 3, characterised in that a base of each of the fins (9B) aligns with a base of the central part (9A).

5. A method of manufacturing a tyre, the tyre comprises rubber components, the method comprising a step of making at least one of the rubber components by winding a rubber tape (9), characterised in that the rubber tape (9) is provided on each side of a central part (9A) with a fin (9B), the central part (9A) having a thickness (T1) of 0.3 to 1.5 mm, the fin (9B) having a thickness (T2) less than the thickness (T1) of the central part (9A) and a width of from 0.5 to 5.0 mm.

6. A method according to claim 5, characterised in that saic at least one of the rubber components is at least one of sidewall rubber (3), inner liner rubber and clinch rubber (G4) which is assembled by being wound on to a cylindrical face of a tyre building drum.

7. A method according to claim 5, characterised in that said at least one of the rubber components is a tread rubber (2) wound on a belt (7), the belt being disposed radially inside a tread face of the tyre.

8. An apparatus for making the rubber tape as set forth in any of claims 1 to 4, characterised in that the apparatus comprises an extruder (13) and a pair of calendar rollers (14), the extruder (13) including a die (17) having an extruding hole (16) from which compounded rubber is extruded into a rectangular cross sectional shape, the extruding hole (16) having an opening width WA1 of from 0.6 to 0.9 times the whole width W0 of the rubber tape (9),

and an opening thickness HA1 of from 1.5 to 7.5 times the average thickness (T1) of the central part (9A) of the rubber tape, the calendar rollers (14) being provided therebetween with a gap between which the extruded rubber passes through, the gap having a shape which is similar to but smaller than thme cross sectional shape of the rubber tape.

9. An apparatus according to claim 8, characterised in that the size of the gap is in a range of from 57 to 80 % of the rubber tape.

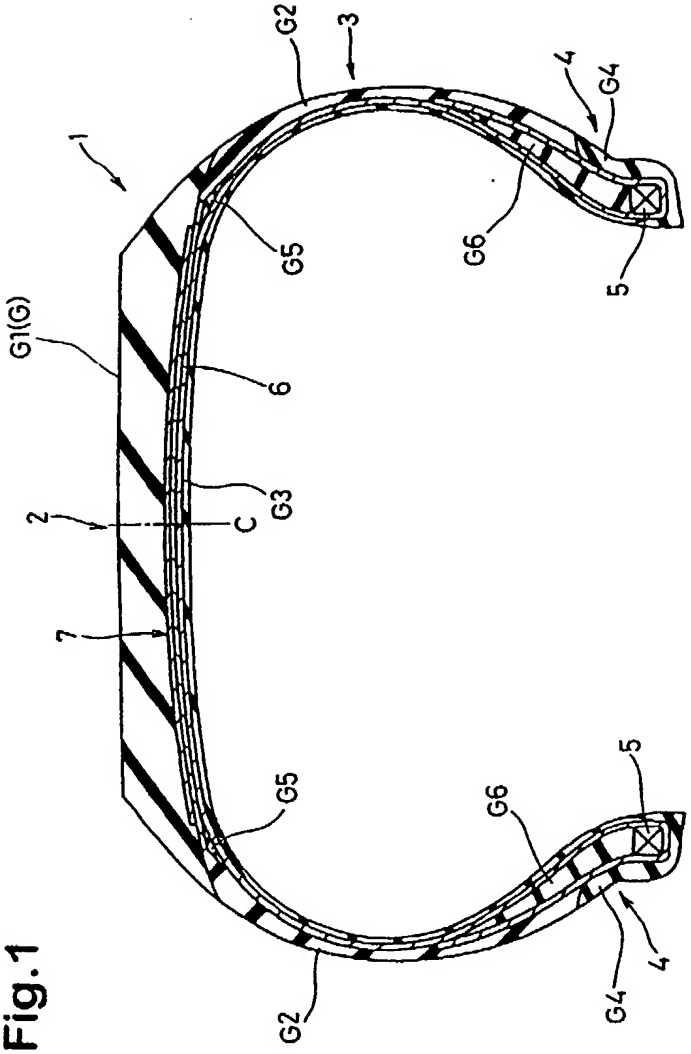

Fig.1

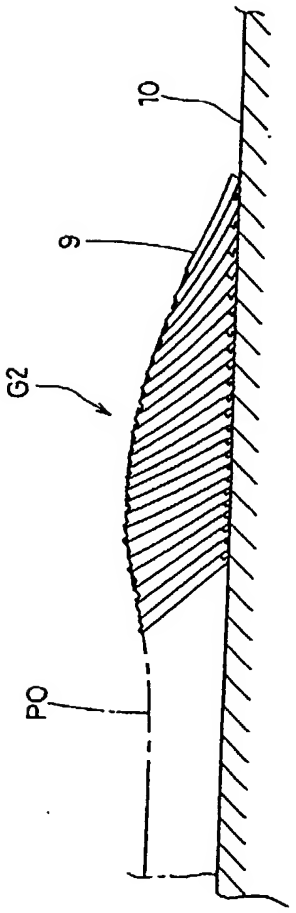

Fig.2

Fig.3

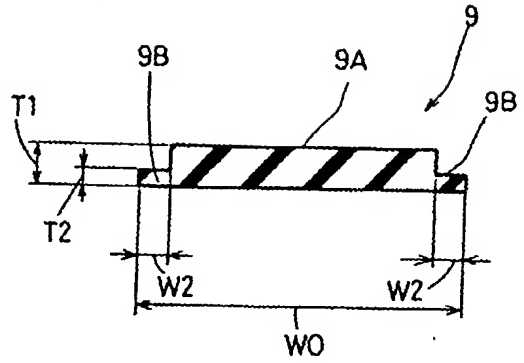

Fig.4

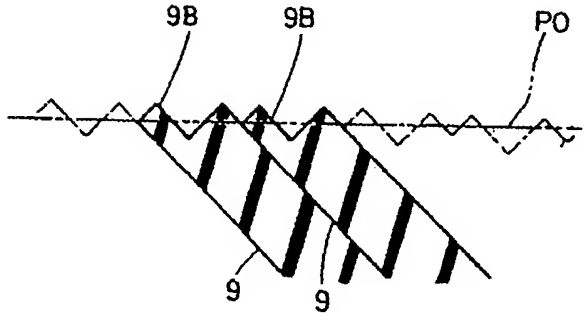

Fig.5A

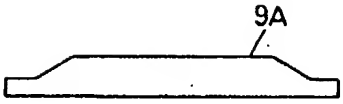

Fig.5B

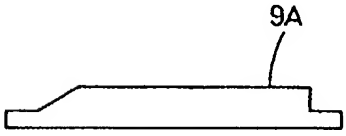

Fig.5C

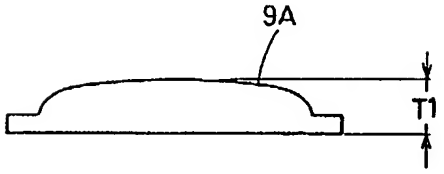

Fig.5D

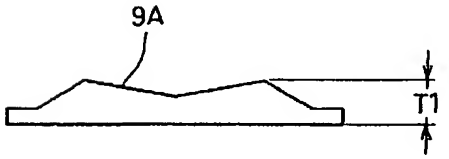

Fig.6A

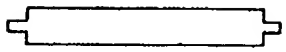

Fig.6B

Fig.6C

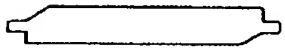

Fig.6D

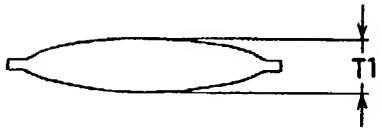

Fig.6E

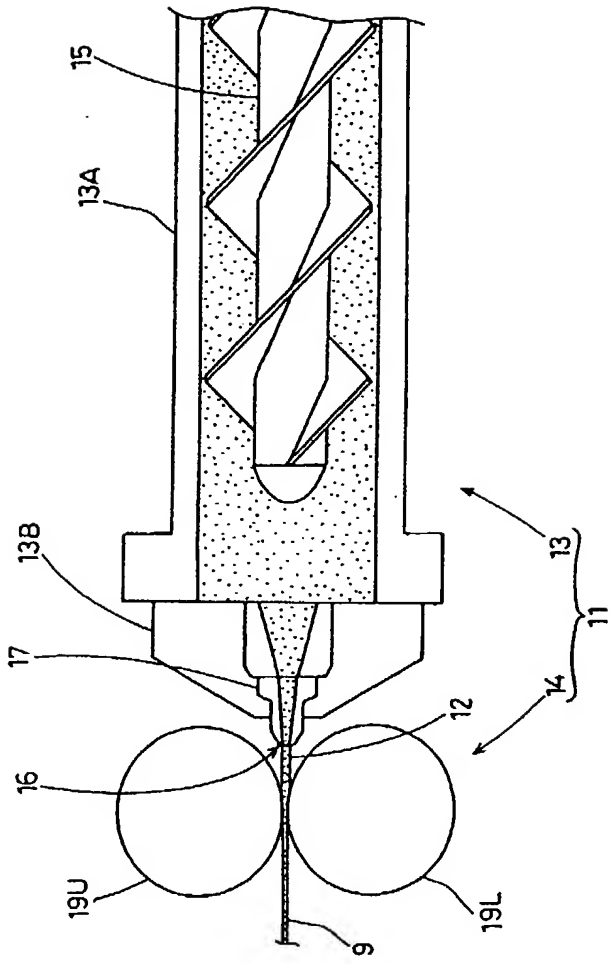

Fig.7

Fig.8

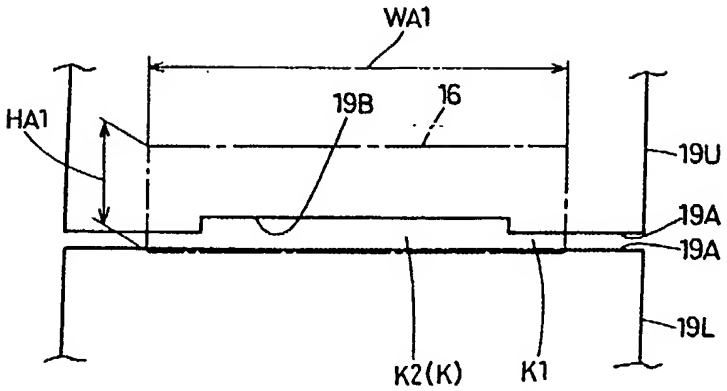

Fig.9A

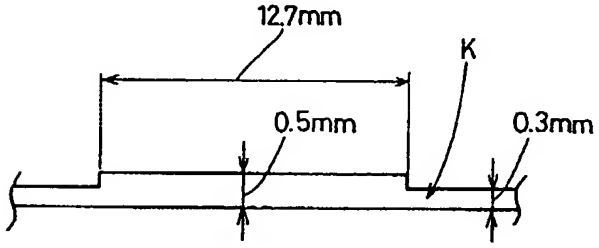

Fig.9B

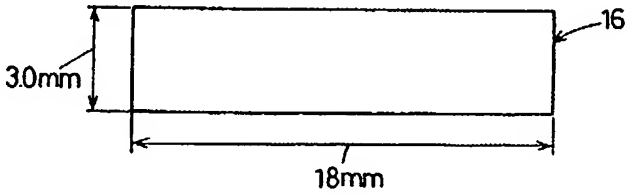

Fig.10A

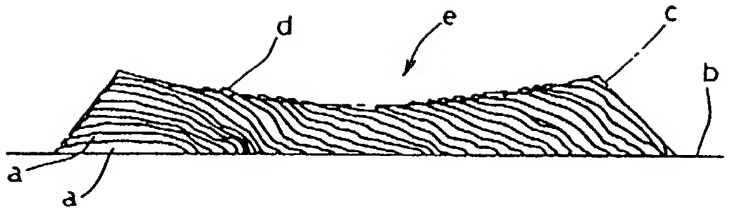

Fig.10B